Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Commercial Technology Office
TOP3–00153

New PMR Polyimide End Caps to Improve High-Temperature Oxidation Resistance

Technology

This patented technology utilizes modified nadic end caps to improve the high-temperature oxidation resistance of PMR (polymerization of monomeric reactants) polyimides, without adversely affecting the processibility of PMR polyimide components or their high-temperature strength.

Benefits

This technology is designed to offer a variety of benefits to PMR components:

- Increase thermo-oxidative stability
- Maintain the desirable flow characteristics of resins, which are important to component processing
- Maintain the cross-linking nature of nadic end caps to maintain high-temperature strength

Commercial Applications

- Aircraft engine composite components
- Aircraft airframe composite components
- Nonaerospace polyimide composite components such as bearings and underhood automotive components

Technology Description

PMR polyimides, commonly used in the aerospace industry, are generally capped at each end by a nadic end cap, which serves a double function. The end cap limits the average molecular weight of the polymer chains (oligomers), thereby allowing improved flow leading to improved processing. Upon further treatment (curing), the end cap cross-links the double bond into a tough, heat-resistant part. However, the nadic end cap accounts for much of the weight loss when the cured polyimide is exposed to high temperatures. This weight loss reduces the

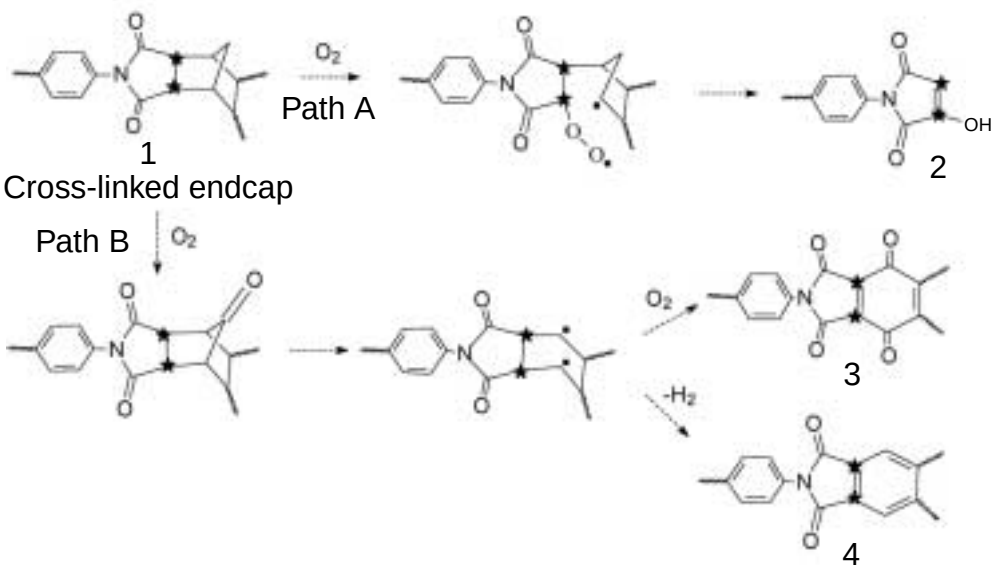

Figure 1.–Pathways/products of norbornenyl end cap oxidation.

lifetime of PMR components at high temperature, which in effect limits PMR polyimides to lower temperature applications.

New end cap technology developed by researchers at the NASA Glenn Research Center offers a solution to the high-temperature oxidation problem typical of polyimides using nadic end caps without sacrificing the desirable features attributed to the nadic end caps. This improvement was discovered by understanding the degradation of the end cap and then exploiting a mode of thermo-oxidative degradation that retards the overall degradation of the affected polyimide. Figure 1 depicts the two primary reaction paths for the degradation of a nadic end cap, path A and path B. Degradation along path A yields cleavage products and results in large amounts of weight loss. In contrast, the products of path B are more resistant to oxidation and form with very little weight loss. The improved new approach seeks to formulate end caps that strongly favor degradation along path B, which leads to lower weight loss and ultimately less shrinkage and cracking in the thermally oxidized layer of the affected polymer.

NASA has developed polyimides with these new end caps and confirmed that they degrade according to path B, but has not produced enough of this material to accurately document the weight loss improvement for these polyimides. Figure 2 provides insight into the amount of weight loss improvement possible for these new end caps. Comparing nadic-capped PMR–15 to a more stable phenyl-capped version; the difference between these two samples can be attributed to the amount of nadic end cap weight loss. The new end cap technology described in this Technology Opportunity sheet is designed to provide this same weight loss improvement, while maintaining the desirable flow and cross-linking characteristics of the nadic end cap.

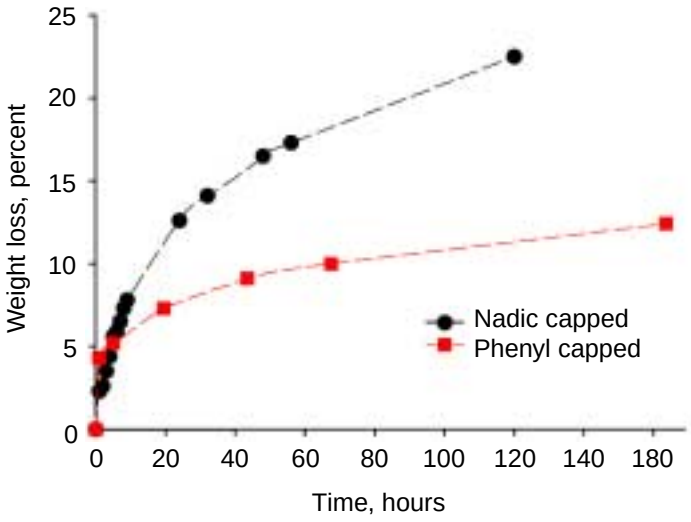

Figure 2.–Nadic-capped PMR–15 weight loss compared to that of phenyl-capped 1500 molecular weight oligomer.

Options for Commercialization

This end cap technology has been bundled with other high-temperature polymer technologies developed at the NASA Glenn Research Center and is available for licensing to produce new and improved commercial products.

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Key Words

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PMR
Shelf life
Materials